

# ACCOMPLISHMENTS REPORT

NOAA's National Climatic Data Center

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# NATIONAL CLIMATIC DATA CENTER MISSION

To Steward the Nation's  
Climate Information

NCDC is responsible for preserving,  
monitoring, assessing, and providing public  
access to the Nation's treasure of climate  
and historical weather data and information.

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This annual report highlights key accomplishments as we continue to carry out critical climate science, develop new and better applications to enable climate data access, and monitor our changing planet.





Artist's concept of the Suomi NPP satellite in space. Credit: NASA/Goddard Scientific Visualization Studio/Ryan Zuber

## ENABLING SUCCESS OF THE SUOMI NATIONAL POLAR-ORBITING PARTNERSHIP MISSION

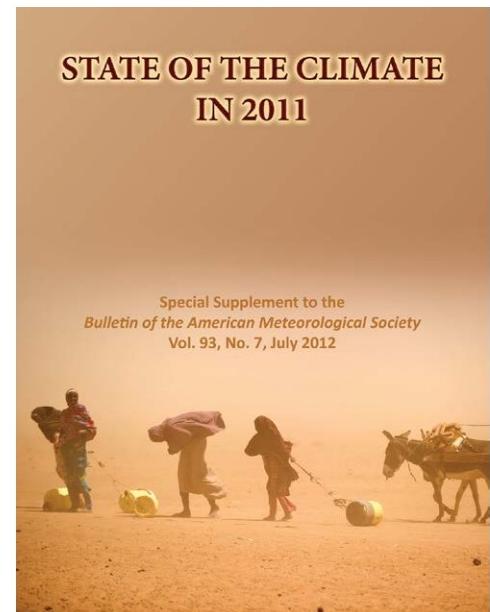
NCDC's Comprehensive Large Array-data Stewardship System (CLASS) team led and participated in archive activities in support of the Suomi National Polar-orbiting Partnership (NPP), which is a joint NASA/NOAA satellite mission. Suomi NPP is the pathfinder or transition mission to the next generation of operational environmental satellites, called the Joint Polar Satellite System, for the United States. Suomi NPP collects and distributes remotely sensed land, ocean, and atmospheric data to the meteorological and global climate change communities. CLASS is the sole designated archive for the mission's data, and the team facilitated rigorous preparation for new data flows, completed successful pre-launch testing, and established new data distribution mechanisms to meet NOAA's and other interdepartmental agencies' emerging post-launch needs. After launch, the excellent

performance of CLASS encouraged new demands and requests for service in response to critical needs for data flows from other NOAA offices and NASA projects. The Suomi NPP mission's data that reside in CLASS represent the latest polar-orbiting satellite technology and extend NCDC's considerable satellite climate data records.

## REPORTING ON THE STATE OF THE CLIMATE IN 2011

The *State of the Climate* series has been an annual supplement to the *Bulletin of the American Meteorological Society* since the report's inception as *Climate Assessment*, led by NOAA's Climate Prediction Center, in 1990. Led by NCDC since 2001, the report has grown in scope to become the leading annual assessment of its type, providing a comprehensive "physical exam" of the climate system each year. The 2011 edition covered a broader range of the climate system than ever before, written by the largest number of authors in its history. It was also accompanied by an online rollout at [www.climate.gov](http://www.climate.gov) for the first time, providing easy access to the key themes of the report for the public.

NCDC provided the editorial leadership for the document, including scientific writing, technical editing, and the actual layout and construction of the document. This involved coordinating the content from 378 authors and more than a dozen chapter editors, increasing the number of Essential Climate Variables to be included, and maintaining scientific integrity of the work. A diverse array of international authors helped consolidate the wide range of expertise needed to more fully understand and communicate the state of the complex climate system. The report provides a valuable reference for the increasing number of professionals and consultants who use climate information in their work. Additionally, as of March 2013, *State of the Climate in 2011* ranked among the American Meteorological society's top 10 "most read" articles for the previous 12 months.



## EXAMINING THE EXTREME EVENTS OF 2012 FROM A CLIMATE PERSPECTIVE

NCDC scientist Dr. Thomas Peterson, along with colleagues from the UK Met Office Hadley Centre and NOAA's Office of Program Planning and Integration, edited a paper entitled "Explaining Extreme Events of 2011 from a Climate Perspective." The paper was published in the *Bulletin of the American Meteorological Society*, and it explains how the odds of six different extreme events of 2011 have changed in response to global warming. The article showed that long-term climate change had no role in the 2011 flooding in Thailand, revealed a decreased likelihood of the cold UK winters like the one in 2010 and 2011, and concluded increased probabilities of several other events such as the 2011 droughts in Texas and the Horn of Africa. By developing the ability to put recent extreme weather or climate events into the longer-term context of climate change, scientists can provide the public with the information needed to make decisions about how to effectively minimize and prepare for the impacts of these variations and changes in the climate system. Additionally, as of March 2013, "Explaining Extreme Events of 2011 from a Climate Perspective" ranked among the American Meteorological society's top 10 "most read" articles for the previous 12 months.

## WEATHER **EXTREMES** OF 2011 IN CLIMATE PERSPECTIVE

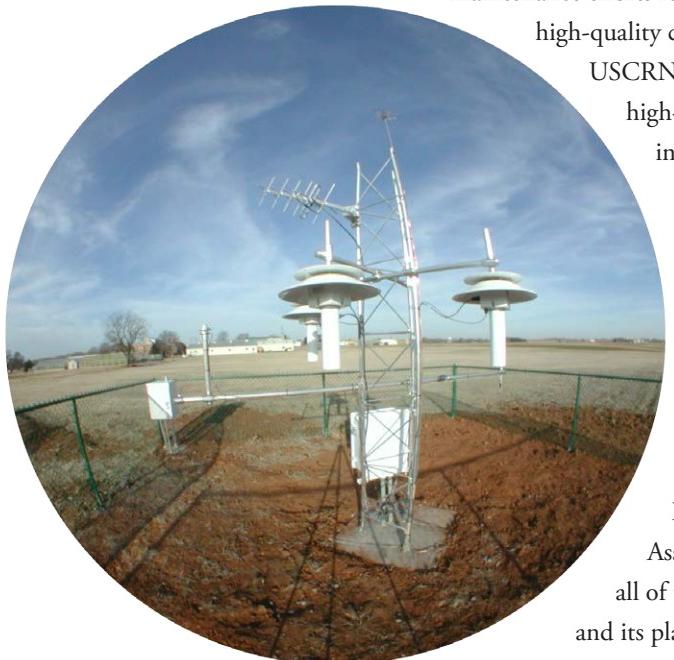
**Taking Attribution Science to the Limits**

## OPERATING THE U.S. CLIMATE REFERENCE NETWORK FOR OVER A DECADE

The year 2012 marks a decade of observations taken by NOAA's U.S. Climate Reference Network (USCRN) under the leadership of NCDC and in partnership with NOAA's Atmospheric Turbulence and Diffusion Division (ATDD). The USCRN consists of 114 stations across the lower 48 United States, and 12 additional sites in Alaska and two in Hawaii, which are specifically designed and deployed for quantifying climate change on a national scale. Each station monitors a suite of meteorological parameters, including primary variables of air temperature, precipitation, soil temperature, soil moisture, and relative humidity as well as secondary variables such as solar radiation and wind. A staff of expert engineers calibrates and maintains the instruments at each site on an annual basis.

These quality measurements combined with thorough metadata documentation, rigorous data quality control, a triplicate sensor configuration for primary measurements, and active maintenance efforts result in a system that can provide high-quality climate data. In the future, the

USCRN will continue to run at the same high-quality standards established in its first decade of operation and continue its expansion in Alaska. Additionally, NCDC and ATDD scientists authored a paper published in the *Bulletin of the American Meteorological Society* and entitled "U.S. Climate Reference Network after One Decade of Operations: Status and Assessment," which further details all of the USCRN's accomplishments and its planned future endeavors.



### COMMISSIONING A NEW USCRN COMPONENT SYSTEM

In 2011, NCDC implemented a sustained soil and relative humidity monitoring program in the USCRN to improve understanding of drought through sub-surface soil observation components of moisture and temperature. In 2012, NCDC completed addition of the new soil-moisture and soil-temperature component system at all 114 USCRN sites in the conterminous United States. As a result, the USCRN now provides the continuous monitoring of soil conditions across the conterminous United States, and has recently begun expanding the installation of those soil sensors at the current total of 12 stations in Alaska.

### FINE-TUNING THE USCRN PRECIPITATION CALCULATION ALGORITHM

To improve precipitation calculations, NCDC conducted a lengthy analysis of the currently deployed pairwise comparison approach to calculating a single best precipitation value from each USCRN station's triplicate measurements. This analysis revealed some weaknesses in the current calculation technique, leading NCDC to develop a new method. This new approach provides a more straightforward accounting based on the 5-minute changes in precipitation depth and provides the public with more accurate information about both climate change and day-to-day precipitation totals.

### REFINING QUALITY CONTROL FOR USCRN SOIL-MOISTURE AND SOIL-TEMPERATURE MEASUREMENTS

To assure the quality of USCRN soil-moisture and soil-temperature observations, NCDC now combines basic real-time quality control with more sophisticated post-processing.

Up until this point, the post-processing system identified sensors that are noisier than others at the same depth, or that significantly deviate in response to environmental forcing like rain events, thereby detecting and flagging values that were out of feasible range. However, other longer-term indications of poor sensor performance were not taken into account.

The new method allows any faulty behavior in any of the three sensors in each USCRN station to be identified by system experts who can place the instrument on a list that will flag all its values until it can be replaced.

## PROMOTING REGIONAL FLOODING AND DROUGHT WEBINARS

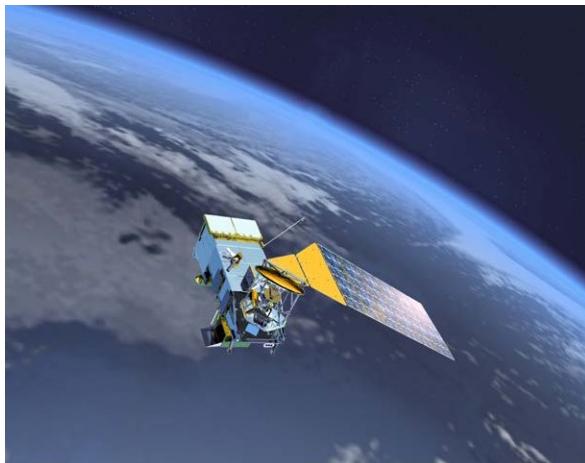
Acting on an expressed need for contextual climate information, NCDC held webinars regarding regional flood and drought impacts throughout the United States. By providing regionally specific details and opportunities to discuss impacts and response options, NCDC's Regional Climate Services Directors (RCSD) improved assistance to government and private sector decision makers, while Climate Services and Monitoring Division and National Integrated Drought Information System personnel developed and implemented custom decision support tools and provided information supporting these activities.

These regional climate webinars began in response to flood impacts experienced in the Missouri River Basin. The webinars responded to damage from May 2011 flooding and the real possibility of flooding again in late 2011 based on fall and winter 2011 outlooks. Beginning in July 2012, Central RCSD Doug Kluck, South Dakota State Climatologist Dennis Todey, Illinois State Climatologist Jim Angel, Kentucky State Climatologist Stu Foster, and the National Drought Mitigation Center conducted the webinars to address the impact of drought and flooding on the Missouri River Basin and the surrounding communities.

As the drought expanded throughout the central and southern United States, the RCSDs delivered additional webinars and forums to connect regional and local stakeholders to climate services that attempt to equip and educate them on the drought impacts. These webinars assessed the current drought status, its historic nature, and the short- and long-term weather and climate outlooks for possible relief. They also helped identify key impacts from the drought on a range of physical and socioeconomic systems and opportunities for improved response efforts in the future. NCDC's drought and climate monitoring data and information products were vital to the services provided for the regions.

These venues brought together a range of weather and climate information providers, along with representatives from a broad cross-section of management and user communities and surrounding areas. These interactions created an opportunity for NOAA's climate services to expand their reach beyond internal partners and have been the springboard for new partnerships with state and local governments as well as with other Federal agencies.





## TRANSITIONING THREE NEW CLIMATE DATA RECORDS INTO OPERATIONS

NCDC expanded the national inventory of operational Climate Data Records (CDR) to 11 by transitioning three new CDRs from research grade to operational status in 2012. The three new CDRs are the Atmosphere Mean Layer Temperatures record, the Sea Ice Concentration record, and the Snow Cover Extent record. Additionally, NCDC performed stewardship activities for the eight operational CDRs in place at the end of 2011 and developed software-coding standards for the generation and sustainment of operational CDRs. These records provide input to emerging climate prediction modeling as well as capture and maintain the Nation's record of climate history, including the severity and frequency of droughts, floods, and hurricanes. The CDRs provide authoritative information used by industry, government, and research communities to detect, assess, model, and predict climate variability and change. Decision makers value these long-term

records and use them to devise effective strategies to better protect life, property, economic interests, and security through climate response, adaptation, and mitigation efforts. To produce these CDRs, NCDC developed long-term, seamless homogeneous records characterizing climate change and variation. As new climate algorithms

and sensor knowledge are developed, NCDC reprocesses the entire period of record to update the data. NCDC applied software engineering expertise and tailored existing standards and best practices to devise new requirements, ensuring that CDR software design and documentation can accommodate migration to future computing platforms and software languages.

The screenshot shows the NCDC website homepage. At the top, there is a navigation bar with links for Home, About NCDC, Contact, Help, and New to Climate Information. Below the navigation is a search bar. The main content area features several sections: 'Data Access' with links to Most Popular Data, Land-Based Station Data, Satellite Data, Radar Data, Model Data, Weather Balloon Data, Marine / Ocean Data, Paleoclimatic Data, Severe Weather, and Other Data Access; 'Climate Information' with links to Climate 4 the U.S., Analyses, Extreme Events, Statistical Weather and Climate Information, Sectoral & Regional, International, Science Papers and Publications, and Support; 'Support' with links to Tools, Partnerships, World Data Centers, Customer Support, Archiving your Data at NCDC, and Education Resources; and 'Climate.gov' with a sub-link 'science and services for society'. On the right side, there is a 'Latest News' sidebar with articles about DROUGHT: History of the U.S. Monitoring System, DROUGHT: Monitoring Economic, Environmental, and Social Impacts, NCDC Insider: Meet NCDC Meteorologist Richard Heim, Continental-Scale Temperature Variability during the Last Two Millennia, DROUGHT: Degrees of Drought Reveal the True Picture, Picture Climate: Why Are Buckets Important to Climate Science?, and Read more NCDC News. There is also a 'Spotlight On' section for the 2013 Products and Services Guide, which is available online. At the bottom, there is a 'Winter Spotlights Water Issues' section with a map of the United States showing water issues across different states, and a link to the 2011 State of the Climate Report.

## REDESIGNING THE NCDC WEBSITE TO PROVIDE CUSTOMER EASE OF USE

In September 2012, NCDC launched its redesigned website, streamlined to better support data discoverability and data access. Modeled after NOAA's website, NCDC will incrementally enhance the site with new tools and capabilities over the coming years and will continue to integrate the site with the NOAA Climate Portal ([www.climate.gov](http://www.climate.gov)).

In addition to its updated appearance and improved internal functionality, the redesigned site makes it easier for the public to find and utilize NCDC's climate data and services. The site also closely leverages NOAA Climate Portal development, which will become a central access point for NCDC data and services. Content management will be improved and made more efficient for contributors. These site enhancements will enable NCDC to make future improvements to the site based on feedback from users and constituents.

## EXTENDING THE TEMPERATURE RECORD IN NORTH AMERICA

NCDC maintains the world's largest collection of climate and environmental data based upon paleoclimate proxies that include tree rings, ice cores, ocean and lake sediments, cave speleothems, corals, boreholes, and historical documents. Through collaborative efforts NCDC used its collection of paleoclimate data to produce a new proxy-based reconstruction of temperature trends for North America extending back to the year 1200. This effort expands the thermometer-based record of temperature, which goes back to 1880 but is too short a time to capture the long-term baseline or natural variability.

Similar to reconstructions of the global average, the data revealed cooler temperatures during the 17th and 19th centuries and warmer temperatures prevailing prior to the 15th century. The average temperature between 1200 and 1980 was 0.2 degrees cooler than during the 20th century (1904–1980).

The reconstruction will be particularly useful for the National Climate Assessment to be published in 2014 and for other efforts focused on regional change in North America. The North American temperature record will also form part of a larger, eight-region climate reconstruction being developed by the International Past Global Changes “PAGES 2K” initiative, ultimately revealing for the first time how temperatures have varied in different regions during the past two millennia.



Scientists look at an ice core from the West Antarctic Ice Sheet Divide coring site.



Which of the following is the closest match for this image of Hurricane Katrina?

The grid shows 12 satellite images of tropical cyclones, arranged in three rows and four columns. The images are color-coded to represent intensity, with red/orange indicating stronger storms and blue indicating weaker ones. The images are arranged from left to right in increasing order of strength. Arrows at the top and bottom indicate the progression from 'Weakest' to 'Strongest'. A large arrow at the bottom indicates the progression from 'Stronger' to 'Strongest'.

Your choice tells us the relative strength of the storm.

## LAUNCHING CYCLONECENTER.ORG—A CITIZEN SCIENCE ALLIANCE PROJECT

NCDC, in partnership with the Cooperative Institute for Climate and Satellites—North Carolina, the University of North Carolina–Asheville, and the Citizen Science Alliance (Chicago, Illinois), developed CycloneCenter.org as an interface for the public to interpret satellite imagery of tropical cyclones in order to estimate their intensity. Launched in September 2012, CycloneCenter.org seeks citizen-scientist volunteers to examine and categorize color-enhanced images from 30 years of tropical cyclones—nearly 300,000 hurricane images from around the world—from the archives of NCDC's Hurricane Satellite Data system. The work has two goals: engage the public in science and educate the public about tropical cyclones.

The method for determining the strength of tropical cyclones has been applied differently around the world and has changed over time. That inconsistency has led to uncertainties in the global historical record of tropical cyclone activity, especially in parts of the world where additional data sources such as aircraft reconnaissance are not available. CycloneCenter.org was developed in an effort to provide a more consistent and complete record.

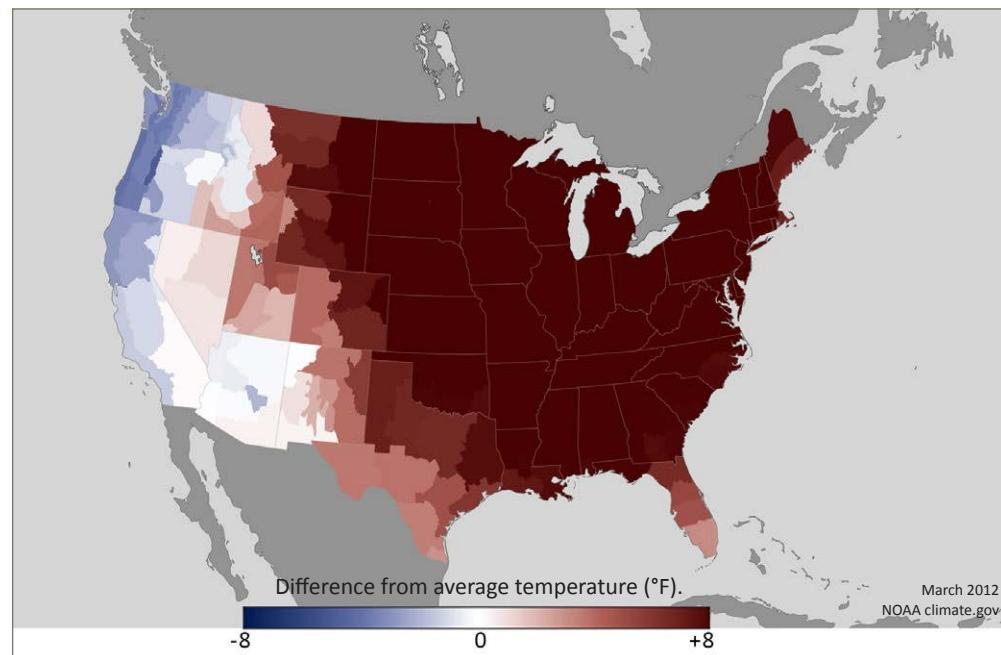
With the public's help, scientists will create a new global tropical cyclone dataset that will provide three-hourly tropical cyclone intensity estimates, confidence intervals, and a wealth of other metadata that could not be realistically obtained in any other fashion. NOAA climate scientists and other researchers will use the new dataset in an attempt to better understand and research global tropical cyclone activity.

## MONITORING AND REPORTING THE RECORD-SETTING WARMTH OF 2012

The year 2012 was the warmest of the 118-year record for the contiguous United States, by about 1°F. Both spring and summer were the warmest on record for their respective seasons. March was the warmest March on record, and July 2012 was the warmest of any single month of the contiguous U.S. climate record. NCDC provided a large volume of additional supplemental monitoring information to better capture the magnitude of these extremes, and leveraged several intra-NOAA partnerships and relationships to help convey this information in a timely manner.

Beginning in March, NCDC created a dynamic supplement to its routine monitoring reports. This space included additional insight, analysis, and explanation on the status of 2012. The supplement implemented several innovative approaches to characterize the unusualness of the warmth. These products and analyses accurately characterize the nature of the extremes observed in the United States.

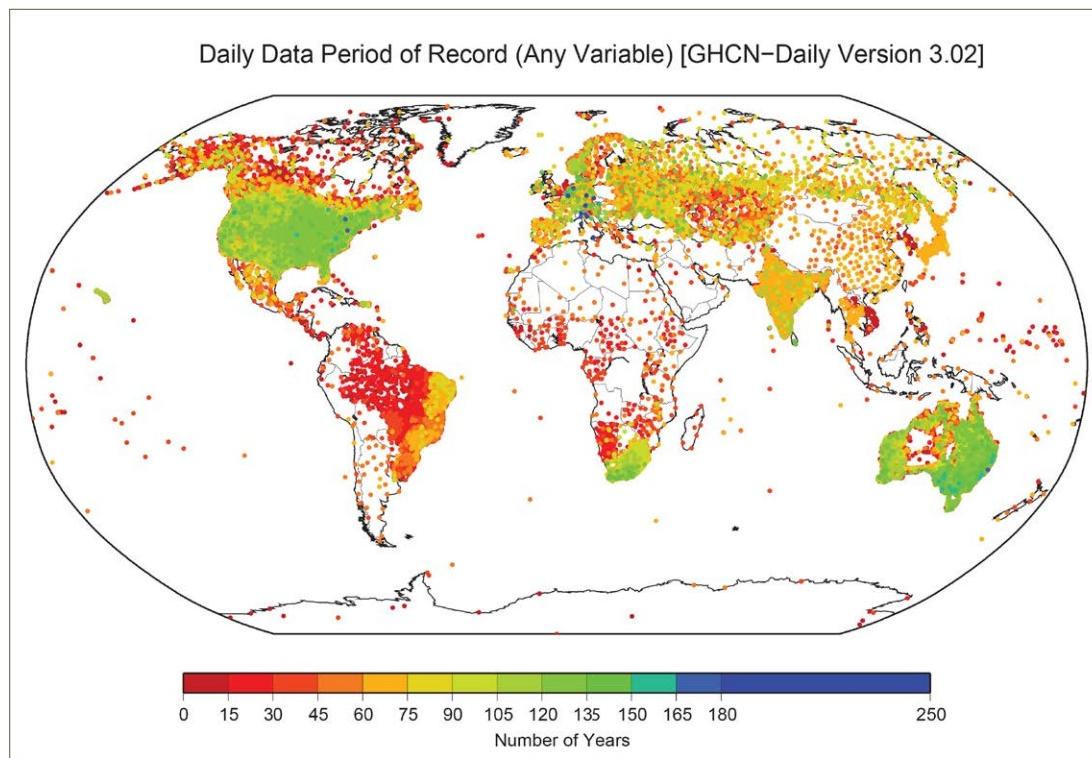
By keeping the Nation abreast of the unfolding extremes throughout the year, NOAA was highlighted as a trusted authority for climate information. NCDC's analysis assisted in helping the public to clearly comprehend the magnitude of the warmth and the impact on agricultural and energy-demand outcomes.



### NCDC IMPLEMENTS INNOVATIVE APPROACHES TO CHARACTERIZE 2012'S WARMTH

- Tables of the magnitude and unusualness of the warmth
- Graphical "Haywood plots" that unambiguously showed, for each of nearly 200 U.S. locations, how its year was unfolding compared to its history
- Additional graphics that captured the warmest 12-month stretches in contiguous U.S. history
- A running analysis of the chances that the contiguous United States would finish with its warmest year on record
- Maps that showed the role of the heat in exacerbating the concurrent drought that plagued the United States
- Videos distributed through [www.climate.gov](http://www.climate.gov) that highlighted various aspects of the event and built climate literacy

## RELEASING REVISIONS OF THE GLOBAL HISTORICAL CLIMATE NETWORK—DAILY DATASET



The Global Historical Climate Network—Daily (GHCN-D) forms the largest source of climate information from surface observing stations and is a widely used baseline dataset with a large and diverse constituency in the fields of agriculture, insurance, hydrology, and energy as well as in climate monitoring. With near-real-time observations combined with a historical record that stretches from the 1800s to present in areas of the world including the United States, this dataset is vital to understanding the impacts of weather and climate on business activity, assessing climate extremes, drought planning and response, energy-demand analyses, and to determine impacts on agriculture in addition to numerous other user-driven needs. As an integrated dataset formed from more than 25 separate component datasets, GHCN-D forms the basis of a number of U.S. and global data products, and is the official archive for U.S. daily data. Data from outside the United States are provided via bilateral and international data-sharing agreements.

In 2012, NCDC released the following improvements:

- A new provenance tracking system was developed to input and ingest data values tracked by the data change- and error-management system known as Datzilla. This new interface between GHCN-D and the Datzilla system allows for full data provenance tracking of values modified via the Datzilla management system.
- A new daily dataset for Russia was integrated into GHCN-D. The Russian dataset was received via a long-standing bilateral agreement between NOAA/NCDC and the All-Russian Research Institute of Hydrometeorological Information-World Data Center.
- Two new station networks for the United States were integrated into GHCN-D:
  1. Daily maximum and minimum temperatures, precipitation, and water equivalent of snow on the ground from the Snowpack Telemetry Network (668 stations), and
  2. Daily maximum and minimum temperatures from the Remote Automatic Weather Station Network (1,454 permanent stations).

## INCREASING NCDC'S DATA HOLDINGS AND USERS' ACCESS TO DATA

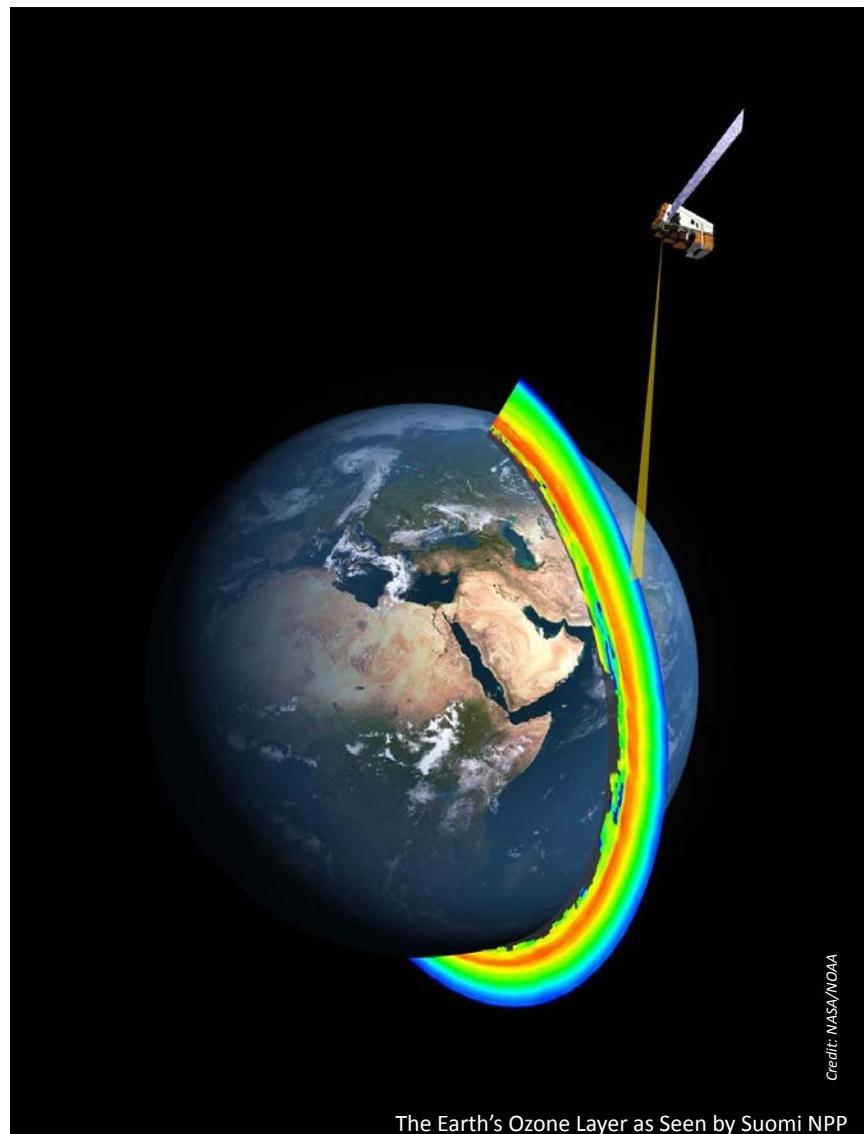
NCDC receives and archives data from all over the world. Throughout the 2012 fiscal year, NCDC consistently advanced its data holdings and improved public access to its data. The International Council for Science continues to classify NCDC as the World Data Center for Climate and Weather.

In the 2012 fiscal year, visitors downloaded 1.911 petabytes of data, which is the equivalent of 25 years of HD-TV video and a 40-fold increase over the 47 terabytes of data downloaded just 7 years earlier (2005 fiscal year). In comparison, the 2011 fiscal year recorded a total download of 1.285 petabytes.

NCDC has also vastly increased its data holdings: a total volume of 9.9 petabytes was present in the archive at the end of the 2012 fiscal year. Over the past ten years, the archive's growth has been exponential, with nearly an 8.5-petabyte increase from the September 2002 archive volume of 1.36 petabytes. It would take almost 2.5 million DVDs, which would stack up nearly two miles high, to hold 9.9 petabytes of data. Once the data is archived, NCDC employs advanced data management techniques to provide these precise weather and climate records to the public.

This meteoric rise in data holdings comes from much more advanced data collection systems such as Doppler radar and today's satellites. For example, the Suomi National Polar-orbiting Partnership satellite orbits Earth every 102 minutes, flying 512 miles above the surface, and capturing data from the Earth's land, oceans, and atmosphere. These data are stored in NCDC's Comprehensive Large Array-data Stewardship System along with a wealth of additional data from other satellites and instruments.

As the world's largest archive of climate data, NCDC's vision is to be the most comprehensive, accessible, and trusted source of climate and historical weather data and information. NCDC enables its customers to respond to the current and changing state of the climate through open access to the Center's data holdings.



Credit: NASA/NOAA

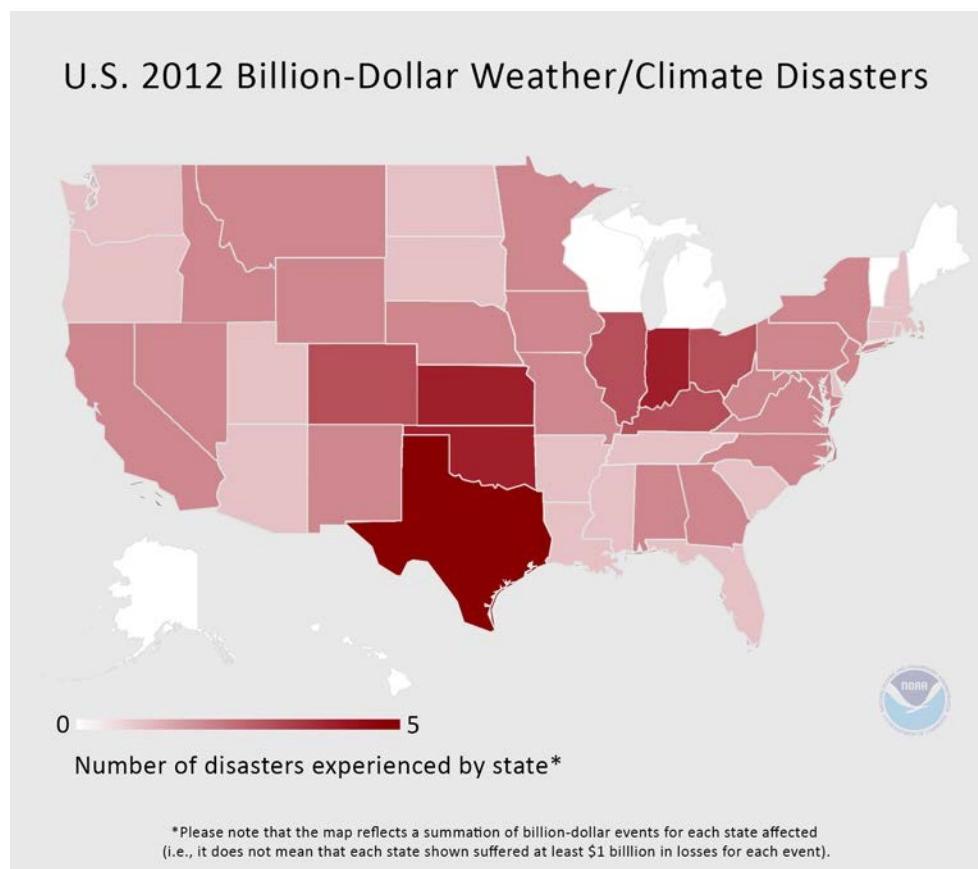
The Earth's Ozone Layer as Seen by Suomi NPP

A cross-section of the Earth's ozone layer as measured by the limb profiler, part of the Ozone Mapper Profiler Suite that's aboard the Suomi NPP satellite. A new instrument, the limb profiler makes high vertical resolution measurements of the ozone layer, a shield that protects the Earth's surface from the sun's dangerous ultraviolet radiation. Smaller amounts of overhead ozone is shown in blue, while larger amounts are shown in orange and yellow. Suomi NPP is a partnership between NASA, NOAA, and the Department of Defense.

## EXAMINING THE DETAILS OF DISASTER ANALYSIS

To better fulfill NCDC's responsibility for issuing an annual summary report on the number and total cost of weather- and climate-related disasters across the United States, the Center hosted the U.S. Disaster Reanalysis Workshop May 3–4, 2012 to ensure that those who compile the report were certain to use the best scientific data in their analysis. This workshop, which convened a panel of disaster risk experts from the public, private, and academic sectors, focused on examining uncertainties and time-dependent biases of datasets used to estimate the direct and indirect economic impacts for various types of disasters.

At the time of the reanalysis workshop, attendees focused on the details from 2011, which was witness to 14 individual billion-dollar weather/climate disasters, breaking the previous U.S. record of nine disasters in 2008. Those 14 events included seven severe weather outbreaks with numerous tornadoes, two major flooding events, two tropical cyclones, one wildfire event, one drought/heat wave, and one snowstorm event. The aggregate damage total of the 14 events exceeded \$55 billion, but did not surpass the record for annual losses set in 2005.



One of many action items from the workshop was publication of a peer-reviewed paper on the topic. Entitled "U.S. Billion-dollar Weather and Climate Disasters: Data Sources, Trends, Accuracy and Biases," the paper, written by Adam Smith (NCDC) and Richard Katz (National Center for Atmospheric Research, Boulder, Colorado), will be published in the journal *Natural Hazards*.

In addition to NOAA's use of the information in its mission to understand and communicate climate science information, media interest in the annual billion-dollar weather/climate disasters report is high and subsequent news reports are gaining attention each year as the events impact citizens. The public and private sector can have great confidence in and rely on the information delivered in the annual reports due to the workshop's effort to better ensure that the report is based on appropriate and robust data and statistical methods. This ensures the statistics presented are as accurate as possible and clearly indicate the uncertainties in the underlying economic data.

Preliminary information on 2012 is available at [www.ncdc.noaa.gov/billions/](http://www.ncdc.noaa.gov/billions/) along with extensive details and graphics regarding the overall time series of reports dating from 1980–2011.

## REPROCESSING GEOSTATIONARY DATA FOR THE GLOBAL SURFACE ALBEDO PILOT PROJECT

Working with 45 terabytes of data, NCDC undertook its largest reprocessing of Geostationary Operational Environmental Satellite data in collaboration with the Cooperative Institute for Climate and Satellites—North Carolina, in order to produce four years of land surface albedo from geostationary satellite visible data. This pilot project is part of the Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) international effort, partnering with Europe and Japan, where participants used the same core algorithm. The results from each international partner will be combined into a nearly global product, which could be expanded to other years in order to produce a thorough climate data record from more than 30 years of geostationary data. Dedicated SCOPE-CM projects, such as this one, aim to bring climate data record capabilities to a higher maturity level and provide better quality data for a variety of applications.

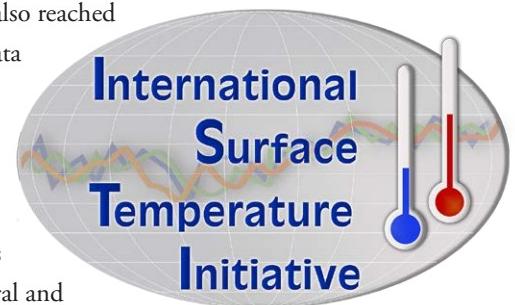
## IMPROVING THE GLOBAL SURFACE TEMPERATURE RECORD DATASET

NCDC improved the global temperature record dataset in 2012 by providing data and analyses of higher quality and establishing a new baseline for reducing uncertainty in the global temperature record dataset. Primary among those advances was the release of the first version of a new global databank of surface temperature data. This databank was developed as part of the International Surface Temperature Initiative, an effort led by NCDC to improve data provenance, version control, openness, and transparency as well as to develop methods for merging disparate sources. The project has uncovered new sources of climate observations and brought the sources together into a single consolidated dataset, thereby filling gaps in data, both temporally and spatially, and providing a more complete picture of the Earth's climate from the 1800s to the present. By integrating more than 50

sources of data into a single dataset, the databank brought the number of stations with mean monthly temperatures to more than 30,000 from 7,280. Moreover, the new methods of data provenance as well as openness and transparency better ensure the integrity of the climate record and provide a higher level of confidence in analyses for scientists and for public and private sector decision makers.

To support the development of an integrated global land surface dataset, NCDC established an international working group to identify previously uncollected sources of data, which more than quadrupled the number of monthly mean temperature stations. New data provenance methods were established, and the databank was constructed in stages so that each phase of an observation—from initial data collection to digitization, proper formatting, merging, quality control, and bias correction—could be documented and preserved. A new method for merging the more than 30,000 stations into a single integrated dataset was established, which involved the development of automated algorithms for performing metadata and data comparisons to correctly identify stations for merging or integrating as unique station records.

Collecting data in the most original form possible, documenting, and making available information on each observation will allow all factors that influence the temperature record, such as method of measurement and computation, observing instrumentation and practices, and quality control, to be better accounted for, and provide superior quantification of uncertainties in the temperature record. Transparency has also reached a new level through the provision of data in stages and by including metadata that provides users with better documentation on the origin and processes to which each observation is subjected. Among the improvements brought by this effort is greater temporal and spatial coverage of temperature observations from the 1800s to the present.



## **ENGAGING PARTNERS TO SUPPORT NATIONAL AND REGIONAL CLIMATE ASSESSMENTS**

Through NCDC and the Climate Program Office, NOAA has been a lead agency in all National Climate Assessment (NCA) efforts. In compiling the 2014 draft NCA, NCDC engaged NOAA's Regional Climate Centers and external experts to contribute to region- and sector-specific reports and published a suite of regional and national assessment climate scenarios that will be incorporated into the final report. NCDC also coordinated the review of all submissions in advance of the final report's release, including public comments on the draft report.

The scenarios stem from a more focused effort than in previous assessments, providing rigorous and consistent climate science underpinning as part of a commitment to a sustained assessment endeavor. This attention will assist in understanding plausible futures and in achieving a consistent base of climate information for each successive synthesis report.

Envisioned and designed as both beneficial to the NCA process as well as directly beneficial to decision makers, the scenarios incorporated eight regional reports and one national report, and in combination represent over 600 pages, 650 images, and approximately 60 tables of information. Approximately 32 authors and an additional 24 contributing authors provided information for the reports, which included observed climatologies and future projections as well as a full description of data sources used. The reports and the underlying maps, graphics, and metadata are available to agency adaptation planning efforts, to the public, and to authors preparing the NCA.

NCDC provides leadership, data, and methodologies to inform the NCA's Climate Indicators program, which brings multiple agency, academic, and state and local partners to the table. This set of indicators, part of the NCA's "Sustained Assessment" strategy, will provide at-a-glance views of the state and changes in the climate system for many years.

## **IMPROVING DATA ACCESS WITH CLIMATE DATA ONLINE VERSION 2**

In 2012, NCDC unveiled an update to Climate Data Online (CDO) with enhanced Geographic Information Services (GIS) better integrated into its product offerings. CDO Version 2 incorporates new technologies, such as direct machine-to-machine access to data and services, via Web Services, and map interfaces through GIS applications that continue to evolve based on user requirements. The release of Version 2 also enabled four old web applications to be retired.

CDO Version 2 consolidates and extends NCDC data access systems by adding or migrating eight products and by adding Web Services access for all datasets and products. The update enhances data discovery through a location/station name search tool, which integrates 10 new dynamic GIS mapping applications, incorporating search by country, state, county, zip code, climate division, climate region, and hydrologic units. Datasets and products include the 1981–2010 U.S. Climate Normals, the Global Historical Climate Network—Daily dataset, global monthly data summaries, Climate Data Records, and many others.

Version 2 makes it easier for the public to find and utilize NCDC's key climate data and services. Web services and GIS services provide customers with much more robust and interoperable capabilities. Customers can now obtain data from the CDO interface or by directly accessing machine-to-machine connections. In addition, creators of mobile device applications are already utilizing these enhanced services in their products.

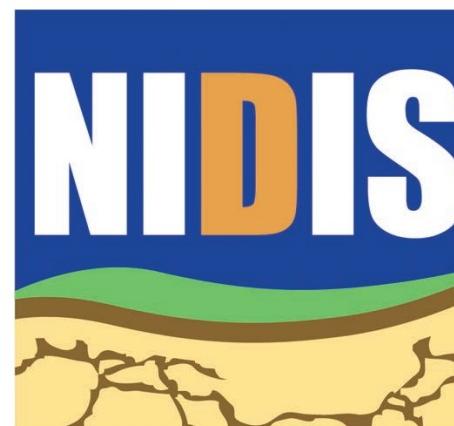
## SIMPLIFYING ACCESS TO GLOBAL OBSERVING DATA

The Global Observing Systems Information Center (GOSIC) was established by the Global Climate Observing System program as a way to provide better and more centralized access to an extremely diverse array of climate-related datasets that cross atmospheric, oceanic, and terrestrial domains and are collected from non-satellite, *in situ*, and satellite observing platforms.

In late August 2012, NCDC launched a new version of the GOSIC Portal website (<http://gosic.org/>). The new site is fully integrated with NCDC's new web infrastructure, which hosts the new NCDC website, the Drought Portal, and the Climate Portal. The GOSIC Portal also completed a major content update in late 2012 to provide more complete access to data and information from the countries that participate in the program.

To aid in improving access to climate observing datasets, the GOSIC staff developed an Essential Climate Variables (ECV) Data Access Matrix. The basic intent of the ECV matrix is to provide users with a centralized resource to access climate observing datasets from trusted sources for each of the defined atmospheric, oceanic, and terrestrial variables as well as metadata and reference documentation. The GOSIC staff is constantly adding new climate datasets identified by the global observing systems and the world data centers as the best available collection of data for a particular variable. Information on spatial and temporal coverage, data gaps, quality control, and additional data needs is also available in the matrix. The ECV Matrix is meant to be a "one-stop-shop" to access trusted ECV datasets and information and can be accessed online at: <http://gosic.org/ios/MATRICES/ECV/ECV-matrix.htm>, and is continually updated to convey the latest ECV-related climate dataset information. GOSIC develops unique value-added products and assists in bringing the *in situ* and satellite climate observing communities together to identify curated ECV datasets for the benefit of the entire climate community.

## FACILITATING INFRASTRUCTURE FOR THE GLOBAL DROUGHT MONITORING PORTAL



As part of an international effort to make drought information available, the United States volunteered to develop a prototype Global Drought Monitoring Portal utilizing the lessons learned establishing the U.S. system. Leveraging existing information technology infrastructure built for the U.S. National Integrated Drought Information System, NCDC

integrated and developed a prototype to deliver global drought information. Both the U.S. and Global Drought Portals are intended to address the critical lack of information related to water, food, and security and to provide economic benefits by enabling access to products and data requested by various public and private organizations.

NCDC coordinated with partners on four continents, the Group on Earth Observation, and the World Meteorological Organization to participate and contribute. The U.S. Drought Portal team solicited user requirements, engaged international partners to obtain data and information, and built an information technology backbone to serve as the global prototype. The prototype was recently recommended to form the substructure of the Global Drought Information System, which is the first step toward a Global Drought Early Warning System. NCDC's Richard Heim and Mike Brewer published further details on the Global Drought Information System in *Earth Interactions*.

## CREATING A NEW INDEX TO FORECAST TEMPERATURE IMPACTS OVER NORTH AMERICA

NCDC initiated a project to develop a new index to distinguish which Madden-Julian Oscillation events will or will not impact temperatures over North America through its partnership with the Cooperative Institute for Climate and Satellites—North Carolina and EarthRisk Technologies, a for-profit company based in California. Called the “Multivariate Pacific-North American Index,” it focuses on the North Pacific and North America, serving as a bridge between the tropical and midlatitude phenomena.

The index uses a preliminary Climate Data Record of outgoing long-wave radiation as a satellite proxy for tropical rainfall along with model reanalyses of the midlatitude circulation. In combination with traditional Madden-Julian Oscillation indices, the new index can provide skillful forecasts of extreme temperatures over the northeastern United States out to 15 days. Such forecasts are a significant improvement and are particularly valuable to the energy industry, which can use them to prepare for an increase in heating or cooling demand and to purchase the needed commodities in advance, thereby leading to a more efficient energy market and lower costs for consumers.

In a related project, NCDC produced a 32-year dataset of upper tropospheric water vapor as estimated from satellites. Through their research, the scientists found that these data could uniquely highlight the interactions between tropical systems and subsequent weather in the midlatitudes of the United States.

## BRIDGING A DATA GAP BETWEEN SATELLITES

NCDC’s production of the microwave-based daily optimally interpolated sea surface temperature (DOISST) was halted when NASA’s Advanced Microwave Scanning Radiometer (AMSR-E) instrument failed in October 2011. This created a gap in data that might not be resolved until the next AMSR becomes

available in 2013. NCDC devised a solution that used an alternate source of sea surface temperature data: the WindSat Polarimetric Radiometer instrument on a Department of Defense satellite. However, differences between WindSat and AMSR-E—such as the equatorial crossing time and instrument design—needed further investigation.

From 2003 to 2011, the period when both satellites were functional, NCDC determined that sea surface temperatures from WindSat could be used to replace AMSR-E data in the DOISST product. First, scientists confirmed that the different equatorial crossing times and swath widths of each satellite would not result in any discontinuities. While scientists did find that diurnal warming differences did exist between the two instruments, the DOISST methodology was able to compensate by using *in situ* data (observations from buoys and ships) to adjust the satellite data, thereby ensuring consistency between the two satellite systems. NCDC’s work ensured the continuity of this critical dataset and helped to bridge the data gap between operational ASMR-E satellite instruments.



Credit: NOAA

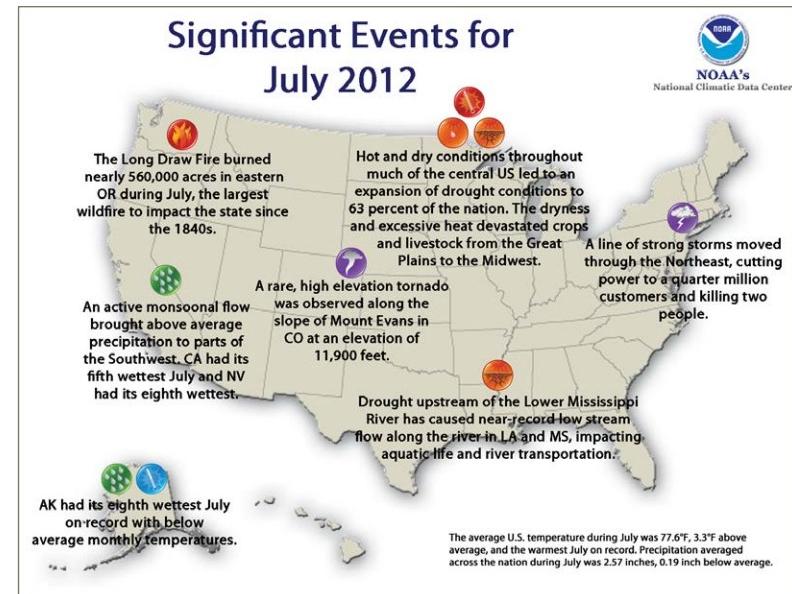
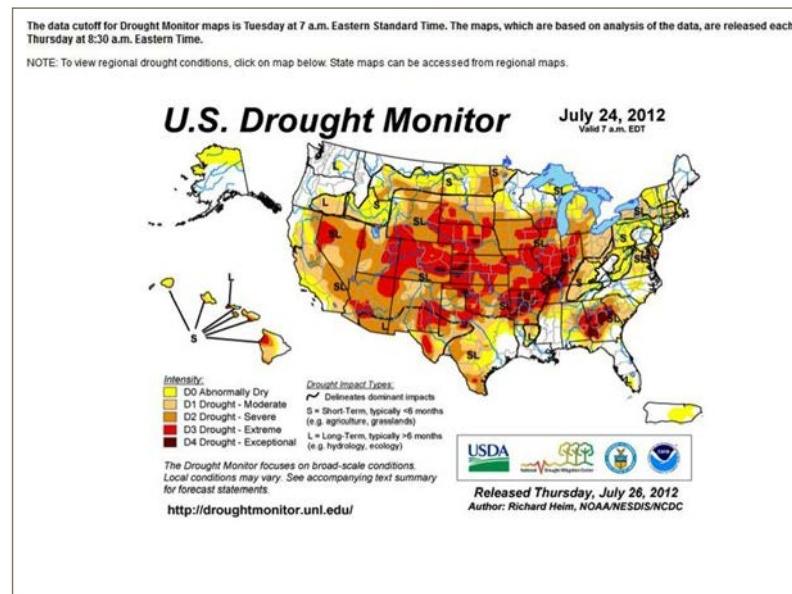
Aguilhas Return Current

## SUPPORTING THE NATION'S UNDERSTANDING OF THE DROUGHT OF 2012

NCDC provided scientific and operational support to help the Nation understand the record-setting drought of 2012. Along with the U.S. Department of Agriculture and academic partners, NCDC employees led the weekly development of the U.S. Drought Monitor (USDM), which is the premier drought assessment product in the United States and relies on input from hundreds of on-the-ground personnel to quality control the product. In addition, information from the USDM is used to distribute billions of dollars in drought-related aid as well as to make state, local, and tribal decisions related to water restrictions.

Drought is second only to hurricanes as the most costly type of natural disaster to affect the United States, and in 2012, the United States experienced its worst drought since the 1950s and, in places, the most intense drought on record. The 2012 drought is expected to cost the economy tens of billions of dollars. No other drought of this magnitude has been monitored so comprehensively in real time in the history of the Nation. As drought emerged during the summer, the Nation was well aware of its magnitude and the complementary roles of heat and lack of precipitation that drove its intensification.

The USDM was produced on time during each week of the drought, despite a monumental increase in the amount of input used in the weekly development. NCDC data and data products were used to compare various aspects of this drought to major events from the past. NCDC employees delivered additional weekly narratives during the drought, which provided insight into the historical significance of the drought, and the various “flavors” of drought and drought impacts that faced different regions of the Nation. More comprehensive monthly summaries provided deeper information. NCDC data and science showed that the abnormal heat during spring and early summer amplified the drought’s severity.



## **CONSOLIDATING DATA INGEST SYSTEMS**

To improve efficiencies in developing, maintaining, and operating its data ingest process, NCDC consolidated multiple systems as well as hardware and software in 2012. The consolidation of the ingest streams resulted in the retirement of the NCDC Archive Management System, which is one of NCDC's legacy systems.

A key component of the consolidation is the implementation of Submission Information Package Generation System (SIPGenSys), which provides the capability to support all data ingest in the Center. More than 60 operational data streams were transitioned to the new system in 2012. To further safeguard the data, SIPGenSys incorporates a data submission manifest, which includes integrity checks to ensure that data were not corrupted during the transfer process.

This improved efficiency within the Center also results in reduced hardware, software, maintenance, and operational costs. In addition, consolidation also increases NCDC's ability to support data ingest, documentation, and long-term preservation, as well as the capability to enforce consistent security and integrity checks on all data files ingested.

### **CLIMATE.GOV 2012 MILESTONES**

- The site experienced a 62.5% increase in visits for the 2012 fiscal year versus the 2011 fiscal year—a much higher growth rate than expected
- 172 new datasets and products were added to the Data and Services section
- Climate-Watch Magazine published 104 new articles, videos, and images during the 2012 fiscal year, as compared with 62 in the 2011 fiscal year, with NCDC making significant contributions to the content throughout the year
- The Climate.gov team launched new Twitter and Facebook social media activities
- NCDC implemented a much more robust IT infrastructure to host the site and to provide greater flexibility for its build-out
- The team completed Phase 1 of the new Content Management System, which included a major effort to determine the new site design for each section

## **ENRICHING NOAA'S CLIMATE PORTAL**

As the host for NOAA's Climate Portal ([www.climate.gov](http://www.climate.gov)), NCDC worked closely with NOAA partners during 2012 to enrich the website with improvements toward users' ability to locate, preview, interact with, analyze, and access climate data and information across NOAA and its partner agencies. Along with a new host server and content management system, which improves and expedites the ability to publish and manage content more efficiently, the redesign of the user interface improves the design and simplifies navigation throughout Climate.gov, which includes renamed sections for easier audience recognition.

The portal's purpose is to provide science and services for a climate-smart Nation, and the wide range of information it provides access to is used to provide climate-related support for decision making by private-sector entities, government agencies, individuals, and non-government organizations. The Climate.gov project began as a rapid prototyping collaboration among staff from four NOAA offices: NCDC, the Climate Program Office, the National Ocean Service's Coastal Services Center, and the National Weather Service's Climate Prediction Center. A prototype was first placed online in February 2010 in order to gather feedback to develop and evolve Climate.gov in user-driven ways.

Since then, NOAA's Climate Model Portal activities are now being integrated with Climate.gov to provide a seamless interface for users. Climate Forecast System Reanalysis datasets are now fully searchable and accessible via Climate.gov, with other model datasets to be added in 2013. Global temperature model projections are now accessible via the Climate Projections tab of the Climate Dashboard.

## INTRODUCING USER WORKSHOPS

NCDC, along with NOAA's Cooperative Institute for Climate and Satellites—North Carolina (CICS–NC), developed a workshop template for a user workshop series that includes presentations on NCDC, popular NCDC datasets, CICS–NC research, and the University of North Carolina–Asheville's National Environmental Modeling and Analysis Center/Renaissance Computing Institute case studies.

These workshops aim to bring together business leaders, decision makers, entrepreneurs, innovators, and scientists to discuss NCDC's climate data, applications of the data, and future uses of climate information. Through this collaborative discussion, NCDC hopes to uncover innovative opportunities for the market and research needs that can be provided to the scientific and academic communities. The user workshop series ([www.cicsnc.org/events/ddd/](http://www.cicsnc.org/events/ddd/)) are two-day workshop interactions to inform users of NCDC data offerings of sector-specific needs in climate information and to explore future research needs.

The first workshop in November 2012 focused on severe weather data. This workshop provided NCDC with some valuable user feedback. Based on this feedback, NCDC plans to develop a dataset user's manual for one product, increase engagement on climate with industry, cultivate an ongoing repository of climate case studies, and conduct a pilot assessment on data format uniformity. In addition to addressing this user feedback, NCDC will hold the next workshop in March 2013, focusing on frost and freeze data.



©Stockphotos.com/Lise Gagne

## PROVIDING ACCESS TO DATA RECORDS OF GLOBAL SPELEOTHEM OXYGEN ISOTOPE MEASUREMENTS



Villars cave

In 2012, NCDC released cave data that span the period from the Last Glacial Maximum to present, through the Center's paleoclimate branch. An international group of scientists collected the data over the past decade by investigating a relatively dense network of caves. These scientists contributed the results of their work to NOAA, and NCDC subsequently archived the information.

Cave deposits such as stalagmites provide well-dated and greatly detailed records of hydrologic change. Such sites yield data that address key scientific questions surrounding climate sensitivity to greenhouse gases and enhance the skill of state-of-the-art climate models to reproduce scenarios based on varying concentrations of these gases. This compilation of speleothem oxygen isotope records includes quality-controlled values from 60 cores spanning part or all of the last deglaciation and Holocene, provided on a common age scale (calendar years before present, where present = 1950 A.D.) and with common measurement units. In addition to revealing abrupt climate change that occurred at the end of the Last Ice Age and the slow movement of large-scale aspects of the circulation such as the Intertropical Convergence Zone, the cave records reveal regionally distinct patterns from arid to tropical landscapes.

By measuring and recording the ratio of the oxygen isotopes, layer thickness, and other properties, the scientists' work extends the record of environmental variability far beyond the instrumental record that spans the last century. By revealing the long-term trends and the natural variability, the paleo evidence can improve our understanding of future change and the potential impacts of hydrologic variability on different regions and economic sectors.



## COMPLETING TWO DATA MIGRATION PILOT PROJECTS

NCDC completed two data migration pilots in 2012, demonstrating the Center's ability to migrate historical and operational data to the Comprehensive Large-data Array Stewardship System (CLASS). Successful migration of NCDC data holdings to CLASS will consolidate hardware and decrease the cost of long-term data preservation.

testing, and implementation of the NCDC–CLASS National Center for Environmental Prediction Weather Analysis and Forecast Chart project. The successful migration of this first dataset from the NCDC archive to CLASS demonstrated the functionality of new software and new processes developed to support data retrieval and delivery to CLASS; data reorganization, naming, and packaging for submissions; creation of submission manifests to support ingest into CLASS; and testing internally and with CLASS. The final archived dataset consolidated three NCDC datasets with a total of 416 images and 0.7 gigabytes of documentation.

The second pilot demonstrated the successful planning, development, testing, and implementation of the NCDC–CLASS Next Generation Radar (NEXRAD) Dual Pol and Level 3 pilot, which represents the first operational data flow into CLASS from NCDC. For this pilot, NCDC identified NEXRAD Dual Polarization and Level 3 data, which constitute a subset of the entire NEXRAD data suite. NCDC also developed and implemented software to read the CLASS Ingest Report and to input the status of data files into the database for verification of data ingest. During the two-week pilot, 31,088 out of 31,092 data files totaling 1.4 terabytes were successfully ingested and reported correctly in the CLASS Ingest Reports, while CLASS also correctly identified any failures. Success of these two pilot projects assists NCDC as it looks to move other datasets into CLASS.

## DEVELOPING A METADATA STANDARD FOR DATA HOLDINGS

In 2012, NCDC developed an ISO 19115-2-compliant metadata standard for the Center's data collections, which is crucial for discovery and access to NCDC data holdings. The Center incorporated the metadata standard into NCDC's Advanced Tracking and Resource tool for Archive Collections (ATRAC), which is used to submit and track archive requests. Incorporating metadata into ATRAC improves efficiencies and lowers the cost of metadata development and long-term preservation.

To create the standard, NCDC determined an essential set of attributes needed to define a data collection for discovery and access as well as the additional attributes that support better understanding and usage of the data. Upon approval of the standard, the ATRAC interface was updated to incorporate the collection of metadata, and the interface was deployed and successfully used by internal and external data providers.

## COLEADING THE INTEGRATED MARINE PROTECTED AREA CLIMATE TOOLS PROJECT

NCDC's Climate and Marine Ecosystems team is coleading the NOAA-wide Integrated Marine Protected Area Climate Tools (IMPACT) project. This project serves to develop and deploy tools that make climate data and information more accessible to and usable by marine resource managers in developing management strategies that adapt to or mitigate the effects of climate change on living marine and coastal resources. These tools include the means to better access and visualize climate change data, increase the climate literacy of the managers and protected-area stakeholders, and integrate climate data with ecological data to better inform ecosystem-based management models and decision-support tools.

As part of IMPACT, the NCDC Climate and Marine Ecosystems team and the Climate Data Records (CDR) program are collaborating in the development of an extension to the Weather and Climate Toolkit (WCT) to provide seamless and transparent access to and visualization of satellite-based CDR data specific to the marine protected area (MPA), time range, and environmental variable requested by an MPA manager. This WCT-IMPACT tool eliminates the need for a user to know which dataset holds the data for a certain environmental variable, on what system those data are stored, or in what format the data are archived, thereby speeding up aspects of the elementary research required. In addition to existing visualization, format conversion, and animation functionality, basic data comparison and analysis options are planned for inclusion in 2013.



Credit: NOAA/FKMS

## PARTNERING WITH THE AMERICAN PUBLIC GARDENS ASSOCIATION

NCDC strengthened ties with the American Public Gardens Association (APGA) through several projects over the past year. NCDC provided the APGA with an article describing a variety of NOAA products and services useful for public gardens. After this article, the APGA requested additional product highlight articles for their monthly newsletter, which NCDC is providing. The APGA also worked with NCDC during 2012 to provide cell phone tour materials on the APGA website so that other gardens can use them at their location if they so desire (<http://publicgardens.org/content/noaa-and-apga>). In addition, the APGA is working with the National Plant Diagnostic Network to develop a three-tiered curriculum for the network, with the goal to incorporate some climate change messaging in that curriculum.

NCDC collaboration was highlighted during the APGA 2012 Annual Meeting, during which NCDC's Sectoral Engagement Coordinator Tamara Houston served as a panel speaker during a session titled, "Public Gardens: Launch Pads for Amplifying Public Engagement on Climate Change." Her presentation highlighted NOAA and NCDC activities and resources of interest to APGA. The panel also included presentations by APGA Executive Director Casey Sclar, the Creative Learning and Engagement Opportunities Institute and APGA board member Caroline Lewis, and State Botanical Garden of Georgia's Wilf Nicholls.

All of these actions have benefited the public by emphasizing activities of the APGA and how climate change may affect future gardening activities.



Longwood Gardens



A P G A

## ENHANCING OPERATIONS BEHIND THE SCENES

NCDC completed an information technology infrastructure enhancement project that employs the use of a widely adopted virtualization implementation strategy, which divides one physical server into multiple isolated virtual environments. The decision enables rapid provisioning of systems, centralized administrative management, and the ability to achieve maximum computing density on given hardware.

Upon completion of the virtualization architecture project, the Center began the process of migrating systems and processes to this new virtual environment, greatly reducing the hardware footprint deployed in the Center's computer room. In addition to the contribution to cost savings in relation to power consumption and HVAC expenditures, the modification supports the Federal Government's Green Data Center Initiative.

This transition benefits the public through better support to scientist and software developers at the Center to more rapidly perform research and development and then provide a facilitated path forward to move solutions from research to operations. In addition, by allowing for the provisioning of systems in a segmented architecture, the quality of products should improve with shorter turnaround in overall product development life cycles. With the improvement, scientists and developers can experiment in an environment affording more flexibility and opportunity for tuning and determining optimal configurations. Environments can then be created to facilitate more rigorous and streamlined validation and quality assurance. Lastly, secure and protected operational environments will host the Center's products, applications, and datasets, making them available to the appropriate stakeholders as well as to the public.

As an example of the multifunction ability, the project has enabled the establishment of NCDC's next-generation web presence, which already hosts new releases of Drought.gov and NCDC's own website.



NCDC uses modern archive technology to support high-volume and complex datasets.

## BUILDING A NEW VERSION OF NOAA'S NATIONAL DATA CENTERS E-BUSINESS SYSTEM

The screenshot shows the NOAA NCDC website. At the top, there's a navigation bar with links for Home, About NCDC, Contact, Help, and New to Climate Information? On the right is a search bar. Below the navigation is the NOAA logo and the text "NATIONAL CLIMATIC DATA CENTER" and "NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION". A sidebar on the left lists categories like Data Access, Climate Information, and Sectoral & Regional. The main content area is titled "Online Store" and contains sections for "Products Available" (listing CD-ROMs and DVDs, Posters, Slides, Publications, and Certified Copies), "How to Order" (with a numbered list of steps), and "Checking Order Status" (with a note about viewing order receipt and shipping status). A "SEARCH" button is located at the top right of the main content area.

NCDC continued to enhance Version 2 of NOAA's National Data Centers E-Business System (NES2) to simplify orders across NCDC, the National Geophysical Data Center, the National Oceanographic Data Center, and the NOAA Coastal Data Development Center. NCDC's work not only modernizes the previous NES version, but also allows order processing by both internal personnel and external customers via the Online Store module.

The Online Store interface used by Data Center customers provides a robust, user-friendly environment for placing orders for NOAA products. Since NOAA made all online data and products freely available for all users to download, the interface is used to order and purchase products for offline delivery (by mail) such as CD-ROMs, DVDs, posters, and publications.

The NES2 system is also very flexible, allowing Data Center users to customize the interface and reports, and it provides greater security of customer information and credit card information. Customers are provided the same experience regardless of which Data Center produces the requested product.

## EMPLOYING HUNDREDS OF WORKERS WITH NCDC'S FUNDS AND GRANTS

In the 2012 fiscal year, NCDC received \$66.4 million of which \$21.6 million went toward NCDC's six largest contracts awarded to Global Science Technology, Diversified Global Partners Joint Venture LLC, ERT Inc., SciTech, The Baldwin Group, and Regional Climate Centers. These contracts provided over 120 employment opportunities in Asheville in addition to many others in locations across the country such as Colorado, Hawaii, Illinois, Louisiana, Maryland, Nebraska, Nevada, New York, and West Virginia. Over the year, NCDC awarded the Cooperative Institute for Climate and Satellites nearly \$7 million in grants enabling the employment of 34 onsite personnel in Asheville. Ten other colleges and universities were also awarded grants during the fiscal year. All total, NCDC awarded over \$9 million in grants during the 2012 fiscal year. Additionally, NCDC worked diligently as stewards of the American public's resources, meeting all year-end financial performance metrics.

## ADVANCING THE COOPERATIVE INSTITUTE FOR CLIMATE AND SATELLITES—NORTH CAROLINA



The Cooperative Institute for Climate and Satellites—North Carolina (CICS-NC) supports NCDC's mission of enhancing the collective interdisciplinary understanding of the state and evolution of the full Earth system. Over the past year, CICS-NC research activities have grown and advanced with more than 55 peer-reviewed papers published and over 50 presentations at several dozen conferences, meetings, and workshops.

The CICS-NC staff continues to demonstrate leadership and drive innovation, both nationally and internationally, through contributions to the IPCC Fifth Assessment Report, the International Surface Temperature Initiative, the Global Climate Observing System Working Group on Atmospheric Reference Observations, the World Climate Research Programme Data Advisory Council, and the American Meteorological Society Energy Committee.

### STRUCTURE

**NCICS activities support NOAA NCDC and enterprise climate services. Main collaborative activities are currently organized into 8 streams:**

- Climate Data Records
- Climate Literacy and Engagement
- Surface Observing Networks
- National Climate Model Portal
- National Climate Assessments
- Workforce Development
- Consortium Projects Administrative Support

Additionally, CICS-NC partnered with NOAA to support the authors of the third National Climate Assessment, and CICS-NC scientists form the core of the Technical Services Unit for this assessment. CICS-NC also continues to cultivate activities in literacy, outreach, and engagement, including cultivating a framework for routine engagement with the private sector to develop cutting-edge techniques in climate communications and advance the uptake of climate information.

NOAA's NATIONAL CLIMATIC DATA CENTER

# Hurricane Sandy

The satellite image shows Hurricane Sandy along the mid-Atlantic coastline with its center about 125 miles southeast of Atlantic City, New Jersey. Maximum sustained winds were 90 miles per hour with a central pressure of 27.76 inches. Sandy was within several hours of landfall on the southern New Jersey coastline.

Satellite: Suomi-NPP  
Instrument: VIIRS  
Channels: 5,4,3 (red,green,blue)  
Date: October 29, 2012  
@ approximately 1735 UTC  
Image Source: NOAA Environmental Visualization Laboratory  
Producer: NOAA's National Climatic Data Center  
Creation Date: December 3, 2012

Protecting the past... Revealing the future

  [www.ncdc.noaa.gov/climate.gov](http://www.ncdc.noaa.gov/climate.gov) [www.nmc.noaa.gov](http://www.nmc.noaa.gov)

Poster created by NCDC using Suomi NPP data of Hurricane Sandy.

# EMPLOYEE SPOTLIGHT

## LOCAL SCIENTIST

NCDC's Ahira Sánchez-Lugo was featured on the cover of Asheville's local VERVE Magazine, which provides an in-depth look at Western North Carolina women in the arts, business, fashion, and design. Her role as the scientific coordinator for the World Meteorological Organization's State of Global Climate in 2012 report as well as her devotion to and enthusiasm for monitoring the Earth's climate made her a prime candidate to join the magazine's ranks of featured, inspiring women.



## Hot Opportunity

Local scientist will travel to Switzerland to present breaking news on climate change



By Tracy Rose  
Photography by Rimas Zailikas  
Illustration by Naomi Johnson

When Ahira Sánchez-Lugo was growing up in Puerto Rico, the prospect of a hurricane approaching the island filled her not with dread — but excitement. "For me, being young, I always thought they were fun," she says, recalling how she got to stay home from school and help her family prepare their home for the impending deluge. "For most kids, they live in a bubble. They are not aware ... of potential destruction, how people are suffering."

Then there were the storms themselves. "Just listening to the power, to the rain, the wind, I just thought that was amazing. So I guess from a young age I was really interested in meteorology and weather events."

## SEPTEMBER 2012 - YWCA ANNUAL TRIBUTE TO WOMEN OF INFLUENCE (TWIN) AWARD



Imke Durre

Dr. Imke Durre has been recognized by the YWCA in their annual Tribute to Women of Influence (TWIN) Awards.

Imke is a leading expert in the field of climate science who has developed research-quality databases critical to the assessment of climate change and who has advanced user-focused information products, most notably the climate “normals” that appear on television weather discussions every night.

Imke is also active in supporting the career development of those with visual impairments or other disabilities. She mentors blind students, helping them to succeed in math and science, and consults on the adaptive technology requirements for both children and adults. In addition, Imke has served on several national and international committees, and written articles on the importance of facilitating educational and career success for the visually impaired and disabled.

## NOAA BRONZE MEDAL AWARD

Congratulations to Anthony Arguez, Scott Applequist, Imke Durre, Mike Squires, and Russ Vose who were awarded a NOAA Bronze Medal. The importance of their “1981–2010 Climate Normals” project has been recognized by NOAA leadership and is reflected in this significant award.



Anthony Arguez



Scott Applequist



Imke Durre



Mike Squires



Russ Vose

## PEER-REVIEWED PAPERS

NOTE: “...” indicates 3 or more non-NCDC authors.

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## REPORTS AND BOOKS

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- Editors: J. Blunden, and D.S. Arndt
- Associate Editors: H.J. Diamond, A. Sanchez-Lugo, P.W. Thorne, et al.
- Arndt, D.S., and J. Blunden: Introduction
- Privette, J.L., and J.J. Bates: [Sidebar] Satellite climate data records come of age
- Sanchez-Lugo, A., J.J. Kennedy, and P. Berrisford: [Global climate: Temperature] Surface temperature
- Parker, D.E., K. Hilburn, P. Hennon, and A. Becker: [Global climate: Hydrologic cycle] Precipitation
- Y. Xue, Z. Hu., A. Kumar, V. Benson, et al.: [Global Oceans] Sea surface temperatures
- Merrifield, M.A.,..., J. J. Marra, et al.: [Global oceans] Sea level variability and change
- Diamond, H.J: The tropics: Overview
- Diamond, H.J., and B.C. Trewin: [The tropics: Tropical cyclones] Overview
- Kruk, M.C., C.J. Schreck, and P.A. Hennon: [The tropics: Tropical cyclones] Eastern North Pacific basin
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- Bates, J.J., A. Holley-Young, and J.A. Curry: Application for cloud vertical structure to investigate the microphysical and optical properties of cirriform, anvil and deep convective clouds.
- Easterling, D.R., K. Kunkel, and X. Yin: Observed increases in probable maximum precipitation over global land areas.
- Fetanat, G., A. Homaifar, and K. Knapp: Tropical cyclone intensity estimation using temporal and image analysis of satellite data.
- Groisman, P.Ya., R.G. Lawford, and V. Kattsov: Northern Eurasia Earth Science Partnership initiative in 2012: An update.

- Guillevic, P.C., and J.L. Privette: NPP VIRRS land surface temperature EDR validation using NOAA's observation networks.
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- Lee, K., A.J. Wagner, S.H. Lee, D.M. Anderson, and J-K. Kim: Recent warming (2000-2010) and coral growth in the Western pacific warm pool.
- Majhi, I., V.A. Alexeev, J.E. Cherry, J.L. Cohen, and P.Ya. Groisman: Uncertainties in Arctic precipitation.
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- Menne, M.J., R.D. Bornstein, A.T. Ghebreegziabher, and J. Gonzalez: A case study on the impact of homogenizing monthly temperature series along coastal California.
- Nelson, B.R., O.P. Prat, and S.E. Stevens: Diurnal cycle of precipitation using high spatial and temporal resolution quantitative precipitation estimates and radar-reflectivity products derived from National Mosaic and Multi-sensor QPE (NMQ/Q2).
- Peng, G., M. Denning, D. Saunders, M. Iwunze, R. Ullman, and J.L. Privette: A low-cost and efficient way to archive calibration/validation finding for satellite data.
- Prat, O.P., and B.R. Nelson: Mapping the world's tropical cyclone rainfall contribution over land using TRMM satellite data: Precipitation budget and extreme rainfall.
- Privette J.L., W.J. Glance, D. Cecil, and J.J. Bates: Support private sector decision-making with NOAA's Interim Climate Data Records (ICDRs).
- Ritchey, N.A., J.S. Morris, and D.J. Carter: New developments in NOAA's Comprehensive Large Array-Data Stewardship System.
- Schreck, C.J., C.C. Hennon, K. Knapp, and S.E. Stevens: Reanalyzing tropical cyclone intensities with citizen scientists.
- Shein, K.A., S. Johnston, J. Stachniewicz, B. Duncan, D. Cecil, S. Ansari, and M. Urzen: An integrated multivariable visualization tool for marine sanctuary climate assessments.
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- Vasquez, L., G. Peng, M. Urzen, B. Hankins, and H. Zhang: A near real-time monitoring system for NWP forecast and satellite-based products.
- Wahl, E.R., E. Cook, H.F. Diaz, and D.M. Meko: Reconstructing precipitation from temperature and drought-index reconstructions in western North America.

Climate Knowledge Discovery Workshop (IEEE Supercomputing Conference), Salt Lake City, UT:

- Cecil, D.: A tool to refine and visualize essential climate information for marine protected areas.

40th Conference on Broadcast Meteorology (AMS), Boston, MA:

- Ned Gardiner: Customizing climate information for broadcast meteorologists via Climate.gov

24th Conference on Climate Variability and Change (AMS), New Orleans, LA:

- Arguez, A., I. Durre, S. Applequist, R.S. Vose, M.F. Squires, and X. Yin: NOAA's 1981-2010 climate normal.
- Arndt, D.S., and J. Blunden: The SMAS state of the climate series: History, Recent developments and future plans.
- Bell, J.E., and M. Palecki: US Climate Reference Network soil moisture/temperature monitoring.
- Crouch, J., D.S. Arndt, R. Heim, K. Gleason, J. Blunden, and A. Sanchez-Lugo: The climate of 2011 in historical perspective.
- Diamond, H.J.: An overview of the U.S. Climate Reference Network (USCRN) system.
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- Gilford, D., and A. Arguez: The impacts of climate variability on coral bleaching in the Great Barrier Reef.
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- Peterson, T.C., K.M Willett, and P. Thorne: Observed changes in surface atmospheric energy over land.
- Schreck, C.J., III, L. Shi, and J. Kossin: The Madden-Julian Oscillation and equatorial waves in upper tropospheric water vapor.

**30th Conference on Hurricanes and Tropical Meteorology (AMS), Ponte Vedra Beach, FL:**

- Hennon, P.A., K. Knapp, and C.J. Schreck III: Is a homogeneous global record of TC position and intensity possible?

**26th Conference on Hydrology (AMS), New Orleans, LA:**

- Durre, I., M. Squires, R.S. Vose, A. Arguez, S. Applequist, and X. Yin: What's new for snow in NOAA's 1981-2010 U.S. climate normal?
- Brewer, M.J., R. Heim, et al.: The global drought monitor portal: the foundation for a global drought early warning system.
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**28th Conference on Interactive Information Processing Systems (IIPS) (AMS), New Orleans, LA:**

- Ansari, S., J.N. Lott, and S.A. Del Greco: The weather and climate toolkit (WCT).
- Cintineo J.L., T.M. Smith, V. Lakshmanan, and S. Ansari: An objective radar-derived preliminary hail climatology for the contiguous United States.
- Galluppi, K., R.W. Moore, L. Brieger, B.R. Nelson, and A. Hall: Event-driven data management and processing using an integrated rule Oriented Data System (iRODS).
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**18th Conference on Satellite Meteorology, Oceanography and Climatology/First Joint AMS-Asia Satellite Meteorology Conference (AMS), New Orleans, LA:**

- Inamdar, A.K., and K. Knapp: Assessment of calibration performance of the geostationary satellite image visible channel in the ISCCP B1 data.
- Knapp, K.R.: inter-satellite bias of the SIRS water vapor channel determined using ISCCP B1 data.
- Liu, C., R.W. Reynolds, A. Hall, and P.V. Banzon: The optimum interpolation sea surface temperature (OISST) from research to operation.
- Bates, J.J.: International collaboration in research-operations evolution of climate data record processing.
- Semunegus, H., J.J. Bates, et al.: Techniques to improve the Special Sensor Microwave Imager/sounder dataset.
- Young, A.: Complementary use of CloudSat and Aqua-MODIS for detection of penetrating deep convection in the tropical tropopause layer.

**Second Conference on Transition of Research to Operations: Successes, Plans, and Challenges (AMS), New Orleans, LA:**

- Bates, J.J.: Update and impacts of the Sustained, Co-Ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM).
- Johnston, S., W.J. Glance, and E. Kearns: Progress and processes for generating NOAA's climate data records.

**Geological Society of America, Charlotte, NC:**

- Wagner, A.J., K.E. Lee, S.H. Lee, D.M. Anderson, and J-K. Kim: Twenty years of western Pacific warm pool variability as recorded in a porites coral from Chuuk Lagoon.

**Second International Workshop on Climate Informatics, Boulder, CO:**

- Wahl, E., and C. Ohlwein: A unifying mathematical framework for pollen-derived paleoclimate reconstructions.
- Shein, K., S Johnston, J. Stachniewicz, B. Duncan, L.D. Cecil, S. Ansari, and M. Urzen: A tool to refine and visualize essential climate information for marine protected areas.

**Second Symposium on Advances in Modeling and Analysis Using Python (AMS), New Orleans, LA:**

- Hennon, P.A., K.E. Kunkel, and D.R. Easterling; using the Climate Data Analysis Toolkit (CDAT) to compare probable maximum precipitation in CMIP5 models.

**21st Symposium on Education (AMS), New Orleans, LA:**

- Dissen, J.: Climate literacy syllabus challenges for select private sector decision makers.

**Eighth Annual Symposium on Future Operational Environmental Satellite Systems (AMS), New Orleans, LA:**

- Carter, D.: New developments in NOAA's Comprehensive Large Array-Data Stewardship System (CLASS).
- Guillevic, P.C., J.L. Privette, B. Coudert, E. Davis, M.A. Palecki, and J.A. Augustine: Land surface temperature product validation using NOAA's surface climate observation networks – Scaling methodology for the Visible Infrared Imager Radiometer Suite (VIIRS).
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- Privette, J.L., I.A. Csiszar, C. O. Justice, and M. Roman: First light over land: Latest VIIRS results from the NPP/JPSS land validation program.
- Csiszar, I.A., J.L. Privette, C.O. Justice, and M. Roman: NPP VIIRS land product status.

**16th Symposium on Meteorological Observation and Instrumentation (AMS), New Orleans, LA:**

- Morrissey, M., H.J. Diamond, M. McPhaden, and H.P. Freitag: an investigation of the consistency of TAO buoy-mounted capacitance gauges along the equatorial tropical Pacific.
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